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A review of the *Chrysolina* species – subgenus *Stichoptera* Motschulsky, 1860 – in Switzerland, with notes on distribution, conservation and preimaginal stages (Coleoptera, Chrysomelidae)

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Abstract

The species of the subgenus *Stichoptera* occurring in Switzerland are revised, based on a combination of literature data, old museum specimens and recent material. Four species, one with two subspecies, *Chrysolina kuesteri* (Helliesen, 1912), *Ch. latecincta latecincta* (Demaison, 1896), *Ch. latecincta norica* (Holdhaus, 1914), *Ch. rossia* (Illiger, 1802) and *Ch. sanguinolenta* (Linnaeus, 1758) are confirmed to occur in Switzerland, while *Ch. gypsophilae* (Küster, 1845) has to be excluded from the Swiss fauna due to insufficient evidence. Errors and unclarities in the older literature are discussed. *Ch. kuesteri* was found abundantly in central Valais, allowing some notes on its larval biology. Larvae of the alpine *Ch. latecincta* are also illustrated, along with notes on its habitat and some past and present distribution records. Illustrations for all Swiss members of the subgenus, as well as distribution maps with all confirmed records, are provided.

Zusammenfassung

Die Arten der Untergattung *Stichoptera*, welche in der Schweiz vorkommen, wurden auf der Grundlage einer Kombination von Literaturdaten, alten Museumsbelegen und aktuellen Funden revidiert. Vier Arten, dabei eine mit zwei Unterarten, *Chrysolina kuesteri* (Helliesen, 1912), *Ch. latecincta latecincta* (Demaison, 1896), *Ch. latecincta norica* (Holdhaus, 1914), *Ch. rossia* (Illiger, 1802) und *Ch. sanguinolenta* (Linnaeus, 1758) werden als in der Schweiz vorkommend bestätigt, während *Ch. gypsophilae* (Küster, 1845) ohne bestätigende Belege ausgeschlossen werden muss. Fehler und Unklarheiten in historischer Literatur werden diskutiert. *Ch. kuesteri* wurde häufig im Zentralwallis gefunden, was zu Beobachtungen über die Larvalbiologie führte. Larven der alpin verbreiteten *Ch. latecincta* werden auch abgebildet, zusammen mit Bemerkungen über das Habitat und historischen sowie rezenten Verbreitungsdaten. Abbildungen für alle schweizerischen Arten des Subgenus, sowie Fundortkarten aller überprüften Funde werden gegeben.

Key Words

Chrysomelinae, biology, larvae, faunistics, Switzerland

Introduction

Leaf beetles (Chrysomelidae) are the third most diverse beetle family in Switzerland and worldwide (Leschen and Beutel 2014), after the Staphylinidae and Curculionidae. Unfortunately, it is also the largest family, which at present still lacks an updated checklist for the Swiss fauna, although both of the larger families have been reviewed in recent times (Luka et al. 2009; Germann 2010). The total number of the Swiss Chrysomelidae species can therefore only be estimated, but may be hovering around 580 according to Löbl and Smetana (2010), and own

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investigations. Within the Swiss Chrysomelidae, it is not only the smaller and less apparent species like those of the Alticinae that have not yet been thoroughly studied (Döberl 1995; Germann 2011), but also the larger-sized species still show considerable gaps regarding their occurrences and distribution data. Recently, Borer and Chittaro (2016) published the first records of *Lilioceris schneideri* (Weise, 1900), and Germann et al. (2020) discussed some of the rarely recorded *Cryptocephalus* species. Also the large-bodied and therefore easily spotted *Chrysolina* species are in lack of specialist attention. As entomologists in neighbouring countries have found alarming population declines in multiple *Chrysolina* species (e.g. Rheinheimer and Hassler 2018), a critical assessment of the situation in Switzerland has become more urgent. In order to inform future conservation measures, a critical re-assessment of the past and present situation has become crucial.

At present, 38 species and subspecies of the genus *Chrysolina* are recorded from Switzerland (unpublished data), five of which in the subgenus *Stichoptera* Motschulsky, 1860: *Ch. gypsophilae* (Küster, 1845), *Ch. kuesteri* (Helliesen, 1912), *Ch. latecincta* (Demaison, 1896), *Ch. rossia* (Illiger, 1802) and *Ch. sanguinolenta* (Linnaeus, 1758). In total, this subgenus contains fifteen valid species and numerous subspecies (Bieńkowski 2001; Kippenberg 2010; Bourdonné et al. 2013; Bienkowski 2019; Kippenberg 2020).

The central European members of *Stichoptera* form a rather difficult species complex, hence *Chrysolina* species with a red coloured margin of the elytra were often confused or misinterpreted in the literature. The 19th century literature cites the species names *Ch. marginalis* Duftschmid, 1825 and *Ch. sanguinolenta* (Linnaeus, 1758) as separate species, even though they are now considered synonyms (Kippenberg 2010), and it seems likely that both names refer to a mixture of species!

Helliesen (1912) was the first to provide a thorough revision of these morphologically similar species within Europe based on a study of the type material, including that of *Ch. sanguinolenta* at the Linnaean Society in London. His excellent identification key is still usable today, in conjunction with illustrations of the genitalia. A more up-to-date key was provided by Winkelman and Debreuil (2008), which also proved useful for the present study.

Kippenberg (2020) recently revised the predominantly alpine *Ch. latecincta* and its subspecies, including specimens from Switzerland. The subspecies *Ch. latecincta vallesiaca* (Franz, 1949), until recently considered endemic to Switzerland (Germann et al. 2013), was synonymised with the nominotypical subspecies. The subspecies *Ch. latecincta norica* (Holdhaus, 1914) was recorded for the first time from Switzerland by Kippenberg (2020).

The present study aims at summarising the current state of knowledge on all members of the subgenus *Stichoptera* in Switzerland, as far as reliable specimens were available, in order to paint a clearer picture of their distribution within the country. We also provide additional data on newly discovered populations of *Ch. kuesteri* in central Valais and details on the larval biology of this species, alongside some notes on the larvae of the alpine *Ch. latecincta latecincta*.

Material and method

The initial idea for this study came after *Chrysolina kuesteri*, a species only recently published as new to the Swiss fauna (Blanc et al. 2012), was observed in surprisingly high abundance in Valais, near Sion, by Annette Geiser-Barkhausen and Urs Lemmenmeier in October 2020. One of us (CG) re-visited the locality later in 2020 and collected adults and larvae. Furthermore, we analysed pitfall trap samples from vineyards around Salgesch and Varen (Valais) made available to us by Lukas Lischer.

We then revised all specimens of *Stichoptera* from Switzerland and immediately adjacent areas contained within the following collections: **AGRO** – Agroscope-Changins, Nyon. **BMNH** – Natural History Museum, London. **MHNG** – Muséum d'Histoire Naturelle, Genève. **NMB** – Naturhistorisches Museum Basel. **NMBE** – Naturhistorisches Museum Bern. **NMSG** – Naturmuseum St. Gallen. **NMCH** – Naturmuseum Chur. **MCSN** – Museo Cantonale di Storia Naturale, Lugano. Collections: **cAS** – Alexander Szallies, Reutlingen. **cCG** – Christoph Germann, Rubigen. **cCM** – Christian Monnerat, Neuchâtel. **cHB** – Hermann Blöchlinger, Erschmatt. **cMB** – Matthias Borer, Liestal. **cRG** – Roman Graf, Kriens. **cSB** – Stève Breitenmoser, Prangins. **cYC** – Yannick Chittaro, Conthey. Data is given verbatim, additions are set in square brackets ([]). The Swiss coordinates are given verbatim.

Pairs of live *Ch. kuesteri* from Mont d'Orge (Sion, Valais) and *Ch. latecincta* from Griespass (Ulrichen, Valais) were kept in multiuse plastic boxes (see Germann 2021) with a diameter of 45 mm and 28 mm hight from autumn until the next summer, and they were generally fed with *Linaria purpurea* (L.) Mill., in order to observe and document their larval development.

Results

Literature review

Stierlin and Gautard (1867) mention *Ch. sanguinolenta* («Ziemlich häufig überall auf Wegen, in Gras.»), *Ch. marginalis* («Selten, wie der vorige [= *sanguinolenta*]. Schaffhausen (St.), Genf (Tourn.)») and *Ch. rossia* [spelt as «*rossii*»] («Selten. Lugano (Meyer)»). Favre (1890) cites only *Ch. sanguinolenta* (« Par places très-commune. Isérables, Fully, Sierre, Niouc (Fav.); Sion (Buy.); aussi à Lully (Jac.) [Kanton VD].») and *Ch. marginalis* («Rare. Val d'Entremont (Rätz.).»). Stierlin (1898) repeated the record of *Ch. rossia* with the general indication «Selten. Im Tessin.», and also listed *Ch. sanguinolenta* «Ziemlich häufig überall auf Wegen und im Gras», but additionally also *Ch. marginalis*: «Seltener als der vorige, Genf, Tessin, Puschlav, Schaffhausen».

Based on the above treatments, we are not able to determine which species these early authors had at hand, considering that *Ch. marginalis* is treated as synonymous with *Ch. sanguinolenta* in the current literature (Kippenberg 2010). Only the information given for *Ch. rossia* matches with our own observations based on voucher specimens in various collections (see below).

Hugentobler (1966) mentions *Ch. sanguinolenta* in his treatment of the beetles of northeast Switzerland and gave the locality «Churfirsten leg. Rietmann». However, no voucher specimen was found in the collection of the Naturmuseum St. Gallen.

Blanc et al. (2012) recorded *Ch. gypsophilae* and *Ch. kuesteri* from Geneva, the latter as a new record for Switzerland. We were able to examine the specimens that formed the base for these records at MHNG.

Records given by Kippenberg (2020) for *Ch. latecincta latecincta* and *Ch. latecincta norica* are based on a thorough morphological revision of these taxa, so we can accept them without hesitation. However, he also points out certain unresolved taxonomic issues with this species complex. *Ch. latecincta* shows considerable morphological variability across its many geographically isolated populations. First results using the barcode sequence (COI) seem promising and may help to shed further light into those populations and/or potential subspecies. For this purpose, we also collected and will continue to collect specimens in alcohol.

General results

Four species and one additional subspecies of *Stichoptera* are here confirmed to occur in Switzerland. All registered specimens and records (Suppl. material 1), and a summary map of both recent and historical records (Fig. 3) shows that three of them were recorded North of the main watershed of the Alps, while all of them except *Ch. latecincta norica* occur in the southern parts of the country (Valais and/or Ticino). The northernmost records from «Basel», «Liestal» and «Schaffhausen» should however be taken with caution, as there might have been a confusion between the collector's home and the actual collecting locality in some of the older specimens (see also Monnerat et al. 2015).

In the following we provide data for all species, including habitus photos (Fig. 1a–g) and those of their male genitalia (Fig. 2a–e). Faunistic records are shown in chronological order.

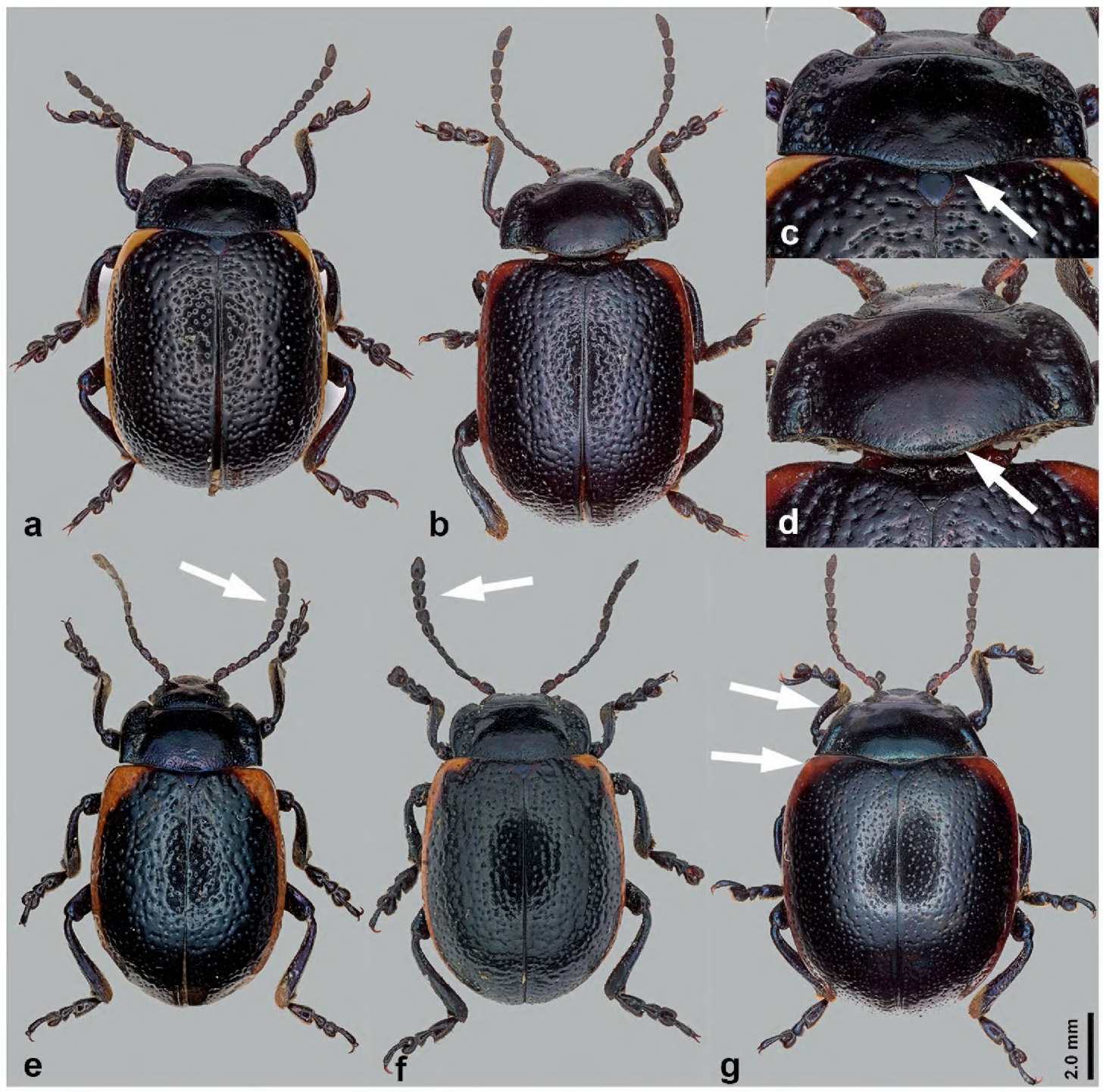

Figure 1. a–g. Dorsal habitus of males of *Chrysolina* (*Stichoptera*) from Switzerland. **a, c.** *Ch. kuesteri*, Raron VS; **b, d.** *Ch. sanguinolenta*, Scuol GR; **e.** *Ch. latecincta latecincta* Griespass VS; **f.** *Ch. latecincta norica* Fusio TI. Arrows indicate relevant differences; pronotum more shiny and glabrous in *Ch. sanguinolenta* (**d**), antennal segments shorter and thicker in *Ch. latecincta* (**e, f**), shape of pronotum trapezoid and circular elytra in *Ch. rossia* (**g**) (Photos: M. Borer, C. Germann).

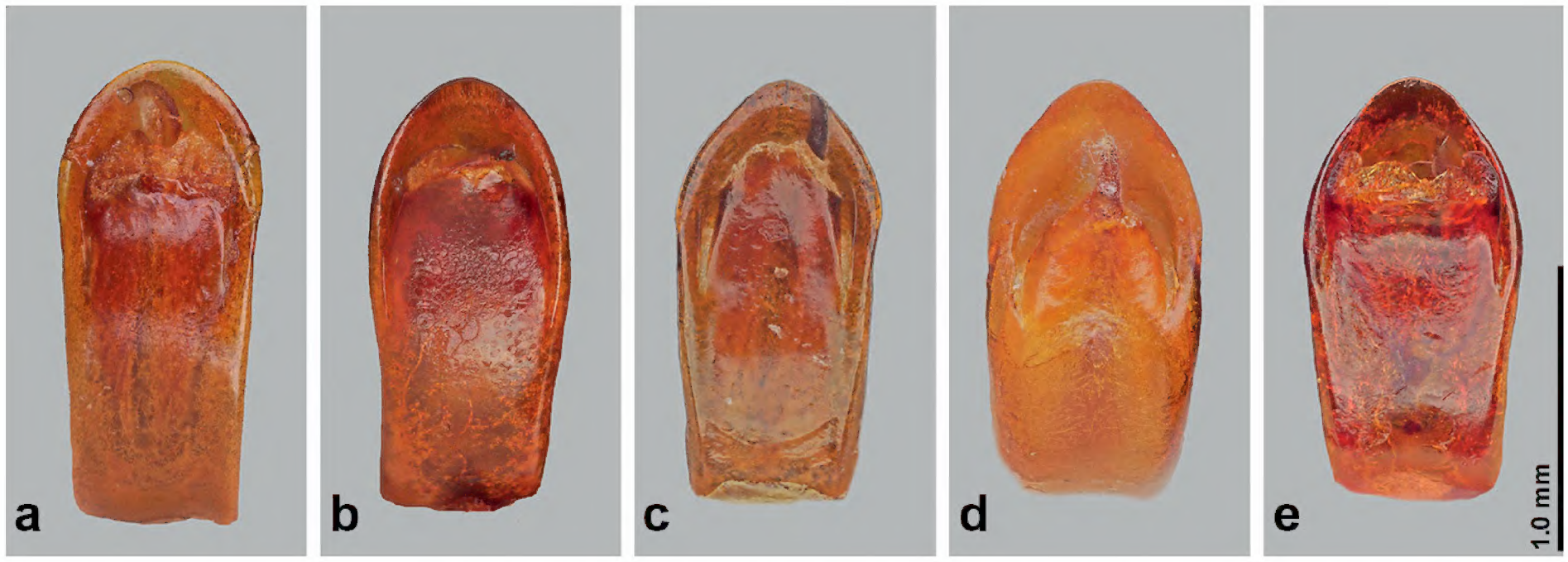

Figure 2. a–e. Apex of the penis (median lobe) of *Chrysolina* (*Stichoptera*) occurring in Switzerland in dorsal view. **a.** *Ch. kuesteri*; **b.** *Ch. sanguinolenta*; **c.** *Ch. latecincta latecincta*; **d.** *Ch. latecincta norica*; **e.** *Ch. rossia* (Photos: M. Borer).

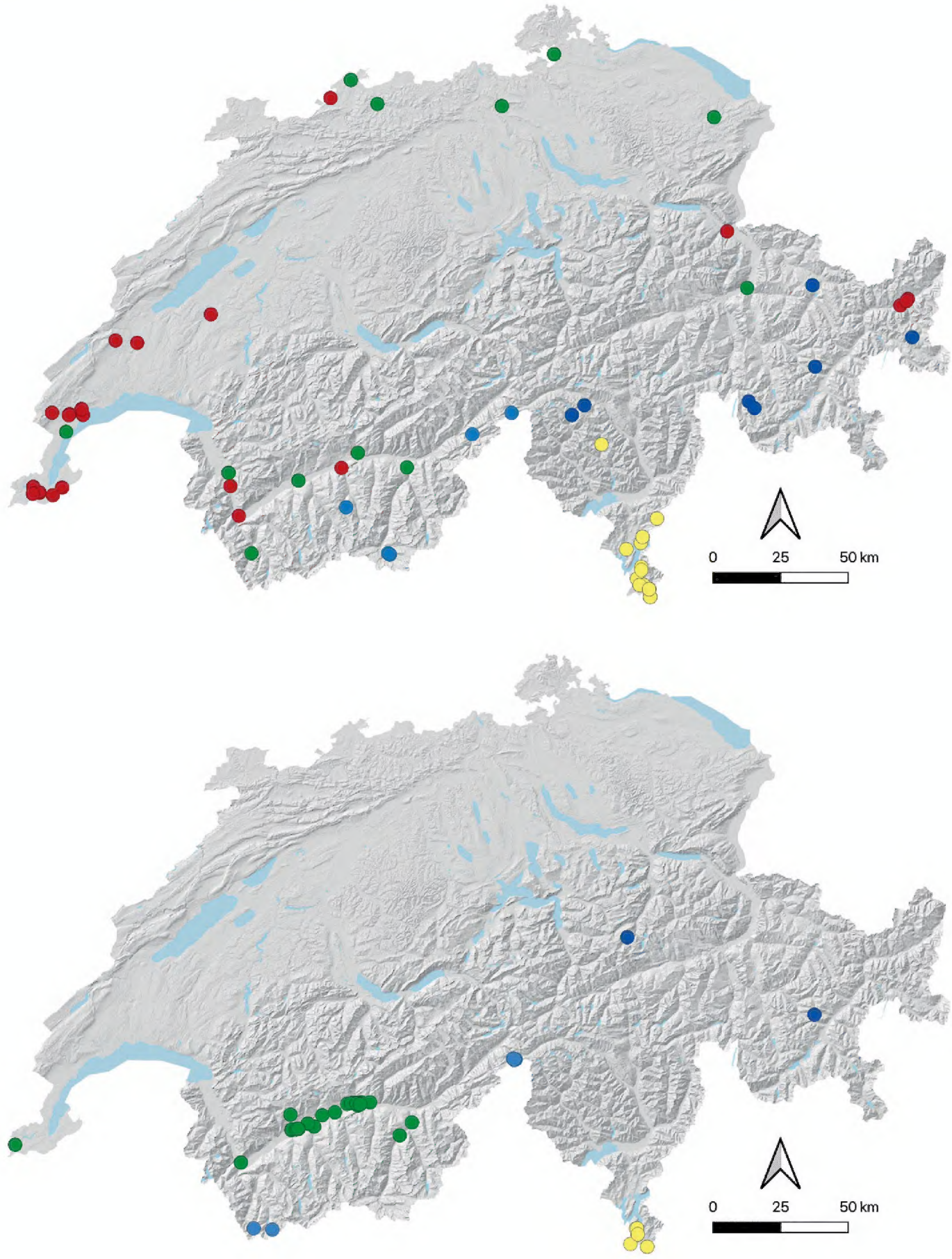

Figure 3. Localities of all revised specimens of the subgenus *Stichoptera* from Switzerland, before the year 2000 (above), and after (below). Colour code: green *Ch. kuesteri*, red *Ch. sanguinolenta*, dark blue *Ch. latecincta norica*, light blue *Ch. latecincta latecincta*, yellow *Ch. rossia* (Background map: swisstopo.ch).

Chrysolina (*Stichoptera*) *gypsophilae* (Küster, 1845)

Note. This species occurs in large parts of Europe, particularly in the South, as well as in the Near East, Caucasus and Central Asia (Kippenberg 2010). There are published records from all countries surrounding Switzerland. In adjacent Baden-Württemberg (Germany), *Ch. gypsophila* has recently been listed as extinct (Rheinheimer and Hassler 2018), for Germany it is listed as "vulnerable" (Fritzlar et al. 2021).

Material. 1 ♀: «Coll. Ch. Maerky Grammont» [Le Grammont, VS?] (MHNG). 1 ♀: Chandolin [VS], 21.6. [before 1929], coll. Maerky (MHNG). 1 ♀: Kippel [VS, almost illegible, handwritten], 21.6. [before 1929], coll. Maerky (MHNG).

Remarks. Blanc et al. (2012) reported this species from «Genève», based on likely misinterpreted historical specimens at the MHNG (the handwritten labels are difficult to interprete). These are likely the same specimens cited above, all from the collection of Charles Maerky. This collection has a reputation for containing frequent labelling errors, making the data altogether unreliable (see Monnerat et al. 2015). The three specimens are all females, and all are supposedly from localities at montane altitudes, which seems odd for this species, otherwise known from lowlands areas (Rheinheimer and Hassler 2018). Because of this unreliability and the lack of other material in collections, we consider the occurrence of this species in Switzerland dubious and advise not to add it onto faunistic lists unless new data become available.

Chrysolina (*Stichoptera*) *kuesteri* (Helliesen, 1912)

Note. This species is widespread in Europe. Kippenberg (2010) cites the nominotypical subspecies from Belarus, Bosnia-Herzegovina, Bulgaria, Germany, France, Latvia, Netherlands, Austria, Poland, Romania, Switzerland, Serbia, Montenegro, Slovakia, Slovenia, Czech Republic, Ukraine and Hungary, while the subspecies *Ch. kuesteri friderici* (Wagner, 1927) occurs in Portugal and Spain. Rheinheimer and Hassler (2018) listed it as thermophilous, localised and rare in SW Germany. Blanc et al. (2012) only recently confirmed the occurrence in Switzerland, but likely based on the specimen in the coll. Charles Maerky at MHNG (see comments under *Ch. gypsophilae* above).

Historical data. 1 ♂, 2 ♀: St. Gallen, ex coll. Täschler [without date] (NMSG). 1 ♂, 1 ♀: Basel coll. Burghold [without date] (NMBE). 1 ♀: Wallis, coll. Burghold [without date] (NMBE). 1 ex.: Genève, La Praille, 7-V. coll. Maerky (MHNG). 1 ♀: «Schweiz» coll. Stähelin-Bischoff [without date], det. J.C. Bourdonné 2005 (NMB). 3 ex. «Basel» (NMB). 3 ex. E. Handschin «Liestal» [without date], coll. E. Handschin (NMB). 1 ♀: Chur [yellow label, without date] coll. Killias, coll. J. B. Jörger (NMB). 4 ex. Basel, coll. [E.] Liniger [1880ies] (NMB). 1 ♂: coll. Chevrier, Nyon, Oct. [18]80 (MHNG). 1 ex. Sion [VS] 22.VI.[18]92 (MHNG). 1 ♀: Rheinau, 6.99 [1899], coll. J.B. Jörger (NMB). 1 ♂: Praz de F [Praz-de-Fort, Orsières, VS] 5.VI.1911 (MHNG). 1 ♀: Rheinau 19.11.[19]12, coll. J. B. Jörger (NMB). 1 ♀ Bex [VD] 14.X.[19]22 (MHNG). 1 ♀: Lägern, Kt. Aarg., Helv. 5.6.1933, coll. V. Allenspach (NMB). 1 ex. VS, Leuk, oberhalb, 30.5.1966, leg. P. Scherler (NMBE). 1 ex. Zeneggen [VS] 4.8.[19]72 (MHNG).

Recent data (2000 onwards). 1 ♀: VS, Kalpetran, 3.6.2000, ex. coll. G. Carron (cYC). 1♀: Helv, VS, Leuk, 615/129, PR2, 26.V.2001, leg. C. Monnerat, det. M. Borer, 2017 (cCM). 1 ex. VS, Sierre, Route Sion 46, 606.247, 126.219, 23.10.2012 (cYC), 1 ♀: VS, St. Léonard, 599, 122, 13.5.2013, leg. R. Graf (cRG). 2 ex.: Hell 662 m, CH-VS-Salgesch, 610787, 129327, 9.xi.[20]14, leg. and det. L. Lischer (cCG). 1 ex.: Marjunne, 709 m, CH, VS, Varen, 613582, 129671, 9.vi.[20]14, leg. and det. L. Lischer (cCG). 1 ♂: Helv, VS, Visperterminen, 634730/122500, 1098 m, 11.V.2017, leg. Y. Chittaro, det. M. Borer 2019 (cYC). 1 ♀: Helv, VS, Varen, 612270-129590, 791 m, 28.V.2017, leg. C. Monnerat, det. M. Borer, 2019 (cCM). 1 ♀: Helv, GE, La Touvière, 488042/114263, 348 m, 24.V.2018, leg. Y. Chittaro, det. M. Borer 2019 (cYC). 1 ♀: Helv, VS, Flanthey, 601540/125155, 952 m, 14.V.2019, leg. Y. Chittaro det. M. Borer 2020 (cYC). 1 ♀: Helv, VS, Brentjong, 616030/129985, 962 m, 31.V.2019, leg. Y. Chittaro, det. M. Borer 2020 (cYC). 1 ♀: Sion, Bisse de Clavau, cours d'eau, vigne [46.25000 / 7.39000], 30.05.2019, leg. S. Breitenmoser (cSB). 1 ♀: Sion, Bisse de Clavau, vigne bosquet [46.25000 / 7.39000], 30.05.2019, leg. S. Breitenmoser (cSB). 1 ex. VS, Conthey, près du Torrent 47, 510 m, 2.II.2020, leg. M. C. Chittaro (cYC). 1 ex. VS, Conthey, près du Torrent 47, 510 m, 27.10.2020, leg. M. C. Chittaro (cYC). 13 ex. VS, Pt. de la Morge, Route de Vuisse, 523 m, 22.4.2020, coll. A. Schmidt (cYC). 1 ♀: Helv, VS, Mayentset, 589812/125364, 1510 m, 22.V.2020, leg. Y. Chittaro, det. M. Borer 2021 (cYC). 1 ♂: CH, VS, Leuk, Erschmatt (Bl), 619.250, 129.925, 1210 m, 13.10.2020, leg. H. Blöchlinger (cHB). 1 ♂: CH, VS, Fully, Les Follatères, 30.9.2020, leg. C. Germann. 1 ♂, 1♀: Sion, Mont d'Orge, 660 m, 592380, 120130 (46°13'58"N, 7°20'24"E), 9.x.2020, leg. A. Geiser-Barkhausen and U. Lemmenmeier (BMNH). 4 ex. 359_20.2 CH, VS, Sion, Montorge, Umgb., 592'590, 120'067, 589 m, 17.10.2020, leg. C. Germann (NMB). 3 ex. 359_20.3. CH, VS, Sion, Montorge, Umgb., 592'490, 120'047, 611 m, 17.10.2020, leg. C. Germann (NMB). 2 ex.: 359_20.4. CH, VS, Sion, Montorge, Umgb., 592'394, 120'144, 660 m, 17.10.2020, leg. C. Germann (NMB). 2 ex.: 359_20.5. CH, VS, Sion, Montorge, Umgb., 591'900, 119'866, 785 m, 17.10.2020, leg. C. Germann (NMB). 1 ex.: 360_20.1 CH, VS, Leuk, Ringacker, 615'119, 129'245, 678 m, 22.10.2020, leg. C. Germann (NMB). 1 ex.: 360_20.2 CH, VS, Leuk, Ringacker, 615'079, 129'260, 675 m, 22.10.2020, leg. C. Germann (NMB). 1 ♂, 1 ex.: 360_20.3 CH, VS, Leuk, ob Ringacker, 615'100, 129'352, 696 m, 22.10.2020, leg. C. Germann (NMB). 3 ex.: 360_20.4 CH, VS, Leuk, Dorf, altes Bahntrassee, 614'965, 129'462, 713 m, 22.10.2020, leg. C. Germann (NMB). 1 ♂: 360_20.5 CH, VS, Leuk,

Dorf, 614'840, 129'595, 704 m, 22.10.2020, leg. C. Germann (NMB). 3 ex.: 360_20.6 CH, VS, Leuk, 614'558, 129'576, 672 m, 22.10.2020, leg. C. Germann (NMB). 1♂, 1 ex.: 360_20.7 CH, VS, Leuk, 614'487, 129'538, 22.10.2020, 657 m, leg. C. Germann (cCG, NMB). 1 ♀: 360_20.8 CH, VS, Leuk, 614'274, 129'486, 636 m, 22.10.2020, leg. C. Germann (NMB). 1 ♀: 360_20.9 CH, VS, Leuk, 615'571, 129'138, 632 m, 22.10.2020, leg. C. Germann (cCG). 2 ex. (Larve und Ei) CH, VS, Sion, Montorge, Umgb., 592'748, 120'105, 560 m, 22.3.2021, vid. C. Germann. 1 ex. CH, VS, Sion, Montorge, 592'600, 120'065, 580 m, 3.6.2021, leg. C. Germann (NMB).

Remarks. Based on our own investigations in Valais, plus the data provided to us by colleagues, *Ch. kuesteri* is locally common around Sion and Leuk. Several previously unknown localised populations were found between in late 2020 and 2021. For a precise map see Fig. 4. All of the older Swiss records we found in museum collections were previously misidentified, mostly standing under *Ch. sanguinolenta*, obscuring the real distribution of this species. Recently « citizen science » observations have become available thanks to iNaturalist (https://www.inaturalist.org/, accessed 1th February 2023), but unfortunately, they leave no possibility of examining characters such as the genitalia more close up. Observations from Sion (8th October 2020), Zeneggen (17th October 2021) and Varen (17th February 2022), all Valais, can be tentatively assigned to *Ch. kuesteri*, but users of this website often seem to confuse this species with *Ch. sanguinolenta* or *Ch. rossia*.

Ch. kuesteri rearing experiments

Note. Six couples of *Ch. kuesteri* from Mont d`Orge (=Montorge Sion, Valais) collected in October 2020 were kept in plastic boxes. As its local host plant in Valais was not exactly determined (but presumed to be *Linaria* sp.), both adults and larvae were fed on *Linaria purpurea*, a readily available garden plant. Oviposition was observed on *L. purpurea* from November until January. In early February 2021 the first larvae were noticed (Fig. 5b), which accepted *L. purpurea* without problems. The first moult took place in mid-February (Fig. 5c), the second towards the end of the same month. In early March,

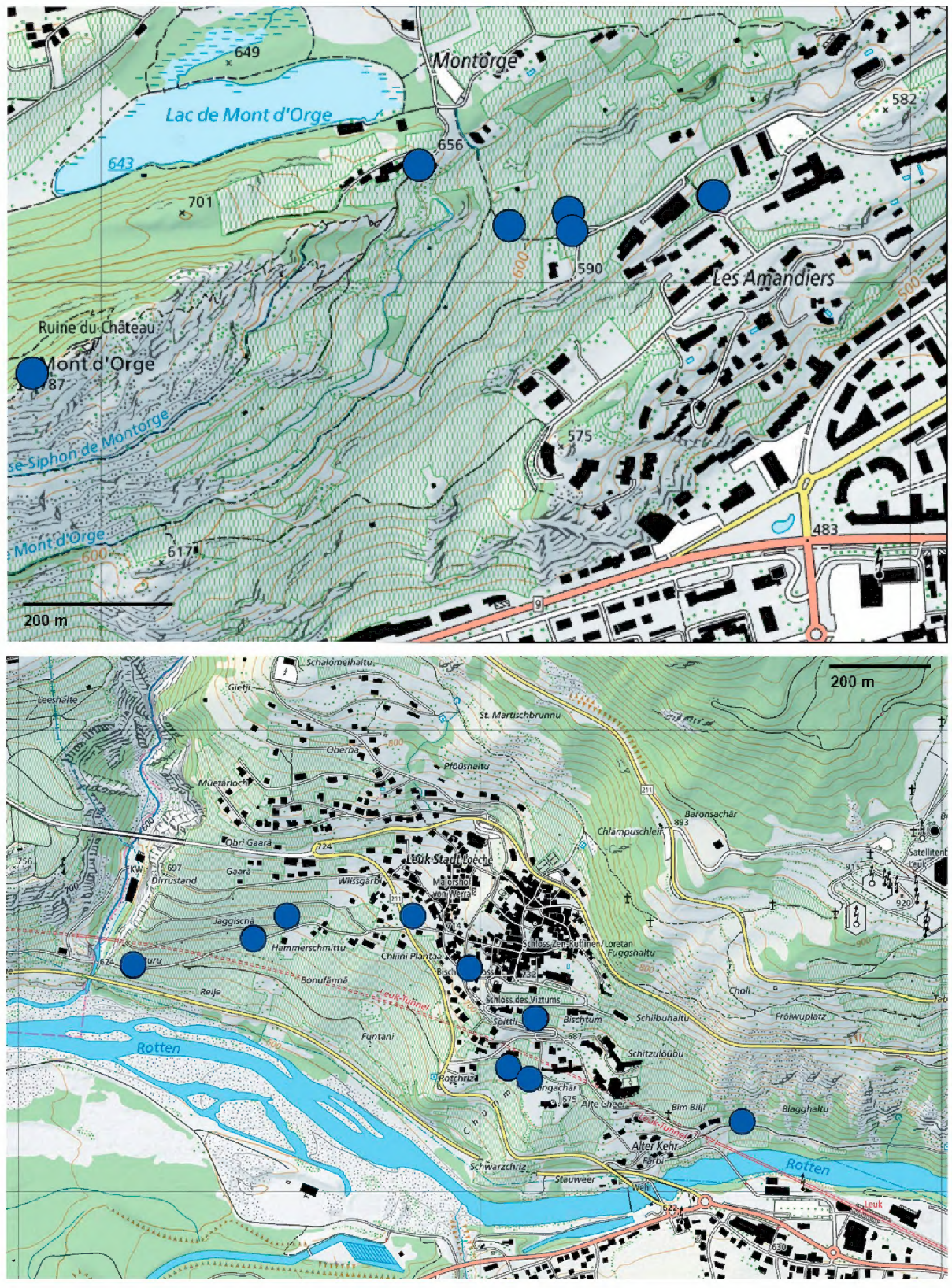

Figure 4. Detailed maps of local *Ch. kuesteri* populations around Mont d`Orge (Sion, Valais) and Leuk (Valais) showing records made in 2020 and 2021 (Background map: map.geo.admin.ch).

Figure 5. a–g. Preimaginal stages of *Chrysolina kuesteri*. **a.** Eggs shortly before hatching, late January; **b.** First larval instar; **c.** Larva after first moult in middle of February; **d.** Larva after fourth moult mid-March; **e.** Fifth (and last) larval instar, April; **f, g.** Pupa, lateral and ventral view; **h.** Freshly hatched adult, end of May (Photos: C. Germann).

more larval skins were found, suggesting a third moult. A fourth moult was observed in mid-March (Fig. 5d), a fifth and final one in mid-April (Fig. 5e). The first pale yellowish pupa (Fig. 5f, g) was found on 30rd April. The larvae pupated at the bottom of the boxes, where some quartz sand had been added earlier. Further pupae followed in May. The first adult hatched on May 29th (Fig. 5h). Part of the adults from autumn 2020 were still alive at that time (Fig. 6a). In addition to those results in captivity (under environmental conditions in Rubigen, outside in

Figure 6. a. Adult of *Chrysolina kuesteri* from Mont d`Orge in October; **b.** Habitat in the vineyards at Mont d'Orge; **c.** Fifth larval instar at the same locality in March 2021 feeding on *Veronica hederifolia* (Photos: C. Germann).

the garden), 5th instar larvae were found in the field near Sion on March 22nd 2021 (Fig. 6c), which shows a somewhat faster development at Mont d`Orge, a locality with exceptionally mild climatic conditions. Only later on, on 22nd March 2021, we found evidence of *Veronica hederifolia* L. acting as the host plant at Mont d d`Orge (Fig. 6b, c).

Some insights into the development of *Ch. kuesteri* were already provided by Bourdonné et al. (2013), who also noted a larval development from October to May, in agreement with our observations and experiments. However, they noted a «quiescence» during the coldest season, which we did not observe. The same authors mentioned *Linaria supina* (L.) Chaz. and *Antirrhinum majus* L. as additional host plants. Rheinheimer and Hassler (2018) reported *Linaria vulgaris* P. Mill. and *L. nivea* Boiss. and Reut. and also quote an observation by Peter Sprick in Lower Saxony (Germany), confirming *Veronica hederifolia* as host plant, matching our field observations.

Chrysolina (*Stichoptera*) *latecincta latecincta* (Demaison 1896)

Note. Based on the recent revision by Kippenberg (2020), this subspecies occurs in the French Alps, NW Italy and southern Switzerland, generally at altitudes above 2000 m. The former subspecies *Ch. latecincta vallesiaca* (Franz, 1949), based on material from Switzerland (Valais), is now included in *Ch. latecincta latecincta*.

Material. 1 ex. [VS] Binn, Eggerhorn, 2400 m, 6.8.[19]46, leg. and coll. E. Handschin (NMB). 4 ex. Rothenboden s. Gornergrat, sous une pierre, alt. 2950, 26.VI.1961 (MHNG). 1 ♂: VS, V. Moiry, 2500 m, 29.7.[19]66, leg. J. Steffen (MHNG). 1 ex.: Valais, Gornergrat, 13.IX.[19]69, s. Pierre 3000–3100 m, Cl. Besuchet (MHNG). 1 ex.: Valais, Gornergrat, 7.VIII.[19]76, 3000–3100 m, Cl. Besuchet (MHNG). 1 ♂: Valais, Gornergrat, 12.VIII.[19]82, s. pierres 3050 m, Cl. Besuchet (MHNG). 10 ex. VS, Ulrichen, Griessee, 16.8.1993, unter Steinplatte im Bereich von kriechender

Salix-Art, leg. E. Kobel (NMBE). 5 ♂, 1 ♀: CH, TI, Cornosee, Geröllhalde, unter Steinen mit *Saxifraga* cf. *oppositifolia*, 2486 m, 46.45805 / 8.38344, 04.VIII.2011, leg. M. Borer, (cMB). 4 ♂, 4 ♀: CH, TI, Cornosee, Geröllhalde, unter Steinen mit *Saxifraga* cf. *oppositifolia*, 2502 m, 46.46004 / 8.38977, 04.VIII.2011, leg. M. Borer, (cMB). 2 ♂, 2 ♀: CH, TI, Cornosee, Geröllhalde, unter Steinen mit *Saxifraga* cf. *oppositifolia*, 2495 m, 672705 / 145639, 11.VIII.2015, leg. M. Borer, (NMB).1 ex. 153_11.2 SCHWEIZ, VS, Orsières, Val Ferret, Ferret, 576.206 / 083.399, 2420 m, 8.9.2011, GS Moos Blocksteinhalde, leg. C. Germann (cCG). 4 ex.: VS, Zwischbergen, Zwischbergengletscher, Moräne, 2700 m, 27.7.2012 (cAS). 5 ex.: 203_13.3 SCHWEIZ, VS, Ulrichen, Nufenenpass, ob. Griessee, Mändeli, 672.090 / 146.080, 2500 m, 29.8.2013, leg. C. Germann (cCG). 11 ex. Ticino, Bedretto, Passo del Corno, hand collecting, 672 550 / 145 700, 2490 m (46°27'32"N, 8°22'59"E), 5. VIII.2019, leg. M. Geiser (BMNH). 15 ex. 386_21.4 CH, TI, Nufenenpass, Val Corno, Cornopass Umgb., 672'589, 145'729, 2400 m, 2.9.2021, leg. C. Germann and M. Borer (NMB). 1 ♂: Helv. VS, Bg-St-Bernard, Troistorr, 583123 / 82917, 2543 m, 20.06.2022 (cYC).

Ch. latecincta latecincta rearing experiments

Note. 15 adults from Griespass (Ulrichen, Valais) were kept alive in couples in the same multiuse boxes (Germann 2021) and kept on *Linaria purpurea* (after the 2nd instar *Linaria vulgaris* was used temporarily), as with *Ch. kuesteri*, which was well accepted. In the middle of September 2021 already three eggs were laid, one of the larvae survived and moulted a fist time till 23rd September, and a second time on 3rd October. From middle of December to February 2022 the larva did not feed anymore and hardly moved. Beginning of March the larva died of unknown reason and despite (or because?) of the mild winter. Three females laid more than 20 eggs (Fig. 7a) from middle to end of March 2022. The larvae hatched in the beginning of April (Fig. 7b, c) and moulted a first time till middle of April, a second (Fig. 7d), third (Fig. 7e, f) and fourth time in May and likely a fifth time till beginning of June (Fig. 7g), when a first pupa was found (Fig. 7h).

Bourdonné et al. (2013) reported, that *Ch. latecincta latecincta* develops on an *Linaria alpina* and *L. supina*, as well as *Antirrhinum latifolium* Mill. in the French Alps (800–1500 m) and they develop from September to April, with a quiescence inbetween. The same authors reported a larval development from May to June for *Ch. latecincta decipiens* (Franz, 1938) from the Pyrenees.

Chrysolina (*Stichoptera*) *latecincta norica* (Holdhaus, 1914)

Note. Kippenberg (2020) lists this subspecies from the Alps of Austria and Switzerland.

Material. 1 ♀: Fusio // Campolungo Fusio 21.7.[19]10 // COF06499 coll. Fontana (MCSN). 2 ♂: Fusio // Campolungo Fusio II.7.[19]12 // *Chrysomela sanguinolenta* // COF06497 coll. Fontana (MCSN). 3 ♂, 4 ♀: Fusio, Ticino, G. C. C. // G. C. Champion Coll. M.B. 1927-409 (BMNH). 1 ♂: Fusio // VII.7.[19]36 // COF06498 coll. Fontana (MCSN). 1 ♂: Parsenn, 11.9.[19]38, leg. Dr. J. P. Wolf (MHNG). 2 ♂: Avers-Cresta, VII-VIII. [19]39, coll. V. Allenspach (NMBA). 1 ♀: Valetta [Piz Vallatscha?], 13.7.(19)45, 2900 m, Schuel [or Schuls, hardly legible], E. Handschin (NMCH). 2 ♂: Albula[pass], 24.VII. [19]49, Dr. J.P. Wolf (MHNG). 2 ex. GR, Avers, Juppa, Bergalga, 25.7.1989, 2007 m, leg. E. Kobel (NMBE). 9 ex.: GL, Claridenfirn, oberhalb Claridenhütte, 2400–2500 m, 22.8.2012 (cAS). 5 ex.: dito 15.8.2013, leg. Schnetzler and Tanaka (cAS). 7 ex. GR, Albula[pass], 783624/ 162365, 2532 m, 15.VIII. 2014, leg. Y. Chittaro (cYC).

Remarks. One of us (MG) revisited the area around Bergalga (Avers) on two occasions, in September 2012 and August 2017. Despite two days of intensive searching, no *Ch. latecincta* were found. Further literature records are adopted from Kippenberg (2020), and Szallies and Brenneisen (2015): Pizol, Albulapass.

A remarkable locality of *Ch. latecincta norica* is Passo Campolungo near Fusio (Ticino), separated from the nearest known populations by some 70 km and several mountain ranges. A single female specimen from this locality was discussed in Franz (1949) and Kippenberg (2020). Seven specimens, including males, collected before 1927 and labelled simply « Fusio, Ticino » were collected by G.C. Champion (BMNH). The Fontana collection (MCSN) contains four specimens from Passo Campolungo dating from 1912 to 1936. These specimens do not show any relevant differences to the other Swiss specimens of ssp. *norica* examined here. A targeted field trip undertaken 1st and 2nd September 2021 by MB and CG did not yield any specimens. The occurrence of the host plants *Linaria alpina* in the area was confirmed (Fig. 8), however, the small, scattered plants might not have provided enough food to sustain a population of the *Chrysolina*. Further exploration of the area, particularly on the Fusio side of the pass, is planned. Unfortunately, it is possible that this interesting, isolated population has already gone extinct in the 87 years since its last sighting.

Chrysolina (*Stichoptera*) *rossia* (Illiger, 1802)

Note. A species primarily distributed in the Balkan Peninsula and Italy but reaching also France and Central Europe. Kippenberg (2010) lists it for Austria, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, France, Greece, Hungary, Italy, Romania, Slovakia, Slovenia, Switzerland and Serbia. In Switzerland, it is restricted to Ticino.

Material. 1 ex. TI, Lugano [without date nor collector] (MHNG). 1 ex. Lugano [without date], leg. and coll. Andrewes (BMNH). 1 ex.: Castello [Castel San Pietro], [without date], COFO6475, GBIFCH00227782, coll. Fontana (MCSN). 4 ex.: Castello [Castel San Pietro], [without date], COFO6478, GBIFCH00227788, coll. Fontana (MCSN). 2 ex.: Castello [Castel San Pietro],

Figure 7. a-f. Preimaginal stages of *Chrysolina latecincta latecincta* from Griespass. **a.** Egg; **b.** Freshly hatched larva; **c.** First instar larval; **d.** Third instar Larva; **e.** Freshly moulted larva after 3rd moult; **f.** Fourth instar larva in February; **g.** Fifth (Last) larval instar; **h.** Pupa (Photos: C. Germann).

[without date], COFO6479, GBIFCH00227789, coll. Fontana (MCSN). 1 ex.: Castello [Castel San Pietro], [without date], COFO6479, GBIFCH00227790, coll. Fontana (MCSN). 1 ex. Lugano, Windrath (MHNG). 1 ex. VS, Martigny [without date nor collector, misplaced or mislabelled specimen] (MHNG). 1 ex. Capolago-Meride, 7.IX.[19]19, Fruhstorfer (MHNG). 2 ex. [TI] Monte Bré, 30.9.[19]22, coll. E. Handschin (NMB). 1 ex. [TI] Rancate, 3.10.[19]22, coll. E. Handschin (NMB). 1 ex.: Castello [Castel San Pietro], 10.1923, COFO6479, GBIFCH00227791, coll. Fontana (MCSN). 1 ex.: Castello [Castel San Pietro], 6.2 [5?].1926, COFO6475, GBIFCH00227783, coll. Fontana (MCSN).1 ex.: Chiasso, 3.6.1928, COFO6473, GBIFCH00227775, coll. Fontana (MCSN). 1 ex.: Chiasso, 10.10.1931, COFO6473, GBIFCH00227776, coll. Fontana (MCSN). 1 ex.: Castello [Castel San Pietro], 3.7.1932, COFO6475, GBIFCH00227784, coll. Fontana (MCSN). 1 ex.: Castello [Castel San Pietro], 11.5.1932, COFO6475, GBIFCH00227785, coll. Fontana (MCSN). 2 ex.: Frasco,

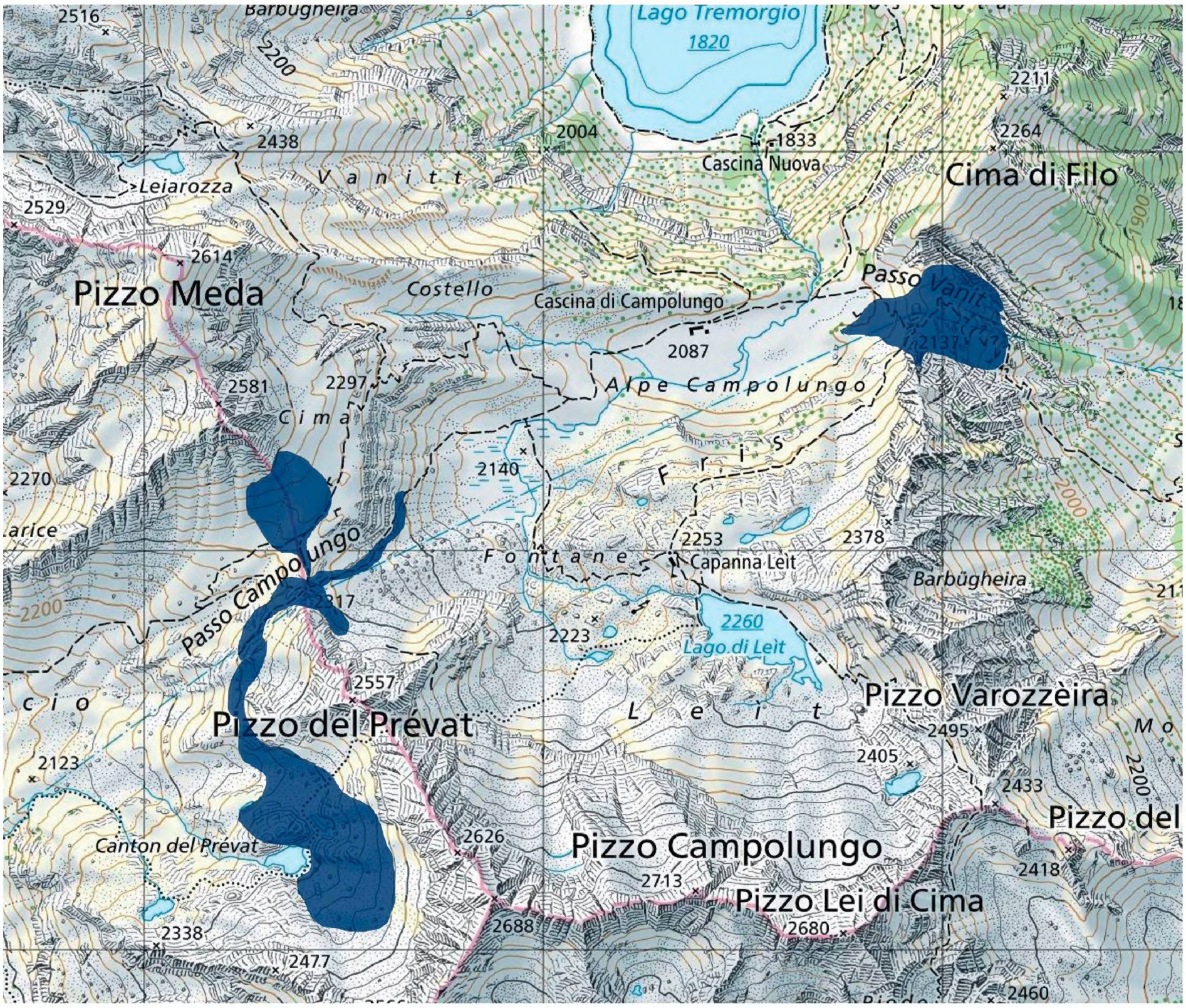

Figure 8. Investigated area around the Passo Campolungo with confirmed occurrences of the host plant (*Linaria alpina*), but without any recent records of *Chrysolina latecincta* (Background map: map.geo.admin.ch).

6.10.1932, COFO6477, GBIFCH00227787, coll. Fontana (MCSN). 1 ex.: Castello [Castel San Pietro], 20.6.1937, COFO6474, GBIFCH00227781, coll. Fontana (MCSN). 1 ex.: Chiasso, 21.6.1939, COFO6473, GBIFCH00227777, coll. Fontana (MCSN). 1 ex.: Castello [Castel San Pietro], 4.3.1939, COFO6474, GBIFCH00227778, coll. Fontana (MCSN). 1 ex.: Castello [Castel San Pietro], 9.6.1939, COFO6474, GBIFCH00227779, coll. Fontana (MCSN). 1 ex.: Castello [Castel San Pietro], 16.6.1939, COFO6474, GBIFCH00227780, coll. Fontana (MCSN).1 ex. Kt. Tess. Salorino 4.[19]40, leg. and coll. J. Lautner (NMB). 6 ex. Kt. Tess. Salorino 8.[19]40, leg. and coll. J. Lautner (NMB). 3 ex.: Chiasso, 29.5.1944, COFO6476, GBIFCH00227786, coll. Fontana (MCSN). 1 ex. [TI] Muzano [Muzzano] 8.10.[19]50, leg. and coll. E. Handschin (NMBA). 2 ex. 1 ex. Comer See [Lago di Como, TI?] coll. Killias, in coll. J.B. Jörger (NMB). 1 ex. TI, Bogno, 5.8.1963, leg. and coll. P. Scherler (NMBE). 1 ex. TI, Rovio, 26.8.1971, leg. and coll. P. Scherler (NMBE). 1 ex. TI, Rancate, 30.7.1975, leg. and coll. P. Scherler (NMBE). 2 ex. TI, Melano, 29.8.1989, leg. and coll. P. Scherler (NMBE). 1 ex.: Helv, TI, Mendrisio, Besazio, Vigna, 718130/80940, 392 m, 07.X.2002, leg. C. Monnerat, det. M. Borer (cCM). 1 ex.: Helv, TI, Chiasso, Pedrinate, 721750/76500, 07.VIII.2003, leg. C. Monnerat, det. M. Borer (cCM). 1 ex.: Helv, TI, Mendrisio, Meride, village, 717625/83270, 05.V.2005, leg. C. Monnerat, det. M. Borer (cCM). 1 ex.: Helv, TI, Stabio, Gerette, 715500/77500, 13.X.2007, leg. C. Monnerat, det. M. Borer (cCM). 1 ex. TI, Meride, 550 m, 718030/ 083360, 4.6.2013, leg. Y. Chittaro, det. M. Borer (cYC). 1 ex.: Helv, TI, Chiasso, Pedrinate, San Stefano, 721818/76517, 450 m, 05.V.2014, leg. C. Monnerat, det. M. Borer (cCM). 2 ex.: Helv., TI, Rancate, 718274/81169, 396 m, 31.V.2016, leg. Y. Chittaro, det. M. Borer 2019 (cYC).

As this species is recognisable even on photographs, recent « citizen science » data are usually trustworthy. iNaturalist (https://www.inaturalist.org/, accessed 1th February 2023) provide supplementary observations (without voucher specimen) from Chiasso (30th April 2015, 27th April 2020), Brissago (19th October 2016), Giumaglio (24th December 2020) and Aquila (30th May 2022).

Chrysolina (*Stichoptera*) *sanguinolenta* (Linné, 1758)

Note. Arguably the most widespread species of the subgenus, found across the Palaearctic Region from Great Britain to eastern Siberia and Mongolia, but absent from the Iberian Peninsula (Kippenberg 2010). Rheinheimer and Hassler (2018) noted that this species has recently seen a sharp population decline in Germany but were not able to name any causes for this.

Material. 1 ex. Genève, Veyrier, 7.VI. [without year] coll. Maerky (MHNG). 2 ♂, 2 ♀: «Basel» [without date, historical collection] (NMBA). 1 ex.: VD, Bavois, 5 [without date], coll. G. Toumayeff (MHNG). 2 ex.: GE, Genève, Bernex, dans rails du Tram, 452 m, coll. Ruchat [without date] (MHNG). 1 ♀: Sargans, leg. Meli 1878, ex coll. Tr [Täschler? Record mentioned in Hugentobler 1966] (NMSG). 1 ex. Niouc [Anniviers] e.V.[18]90 (MHNG). 1 ♂: VS, Sion, 8.V.[18]97 (MHNG). 1 ex.: GE, Chèvres [Bernex] 5.7.[19]03, coll. J. Simonet (MHNG). 1 ♂ : Bex, 9. V. [19]04, leg. and coll. G.E. Bryant (BMNH). 1 ex. Genève, Bel-Air, Rte. d'Ambi[lly], 22.4.[19]17 (MHNG). 1 ♂: VD, St Cergues V. [St-Cergue] 7.VII.[19]21 (MHNG). 1 ♀: Schuls, 28.7.[19]21, leg. E. Handschin (NMCH). 1 ex.: GR, Tarasp, 8.1938, coll. G. Toumayeff (MHNG). 1 ex.: GR, Schuls, 6.1939, coll. G. Toumayeff (MHNG). 1 ex.: Boulex [VD], 7.8.1941 (AGRO). 1 ex. VD, Bursinel, 26.IV.1943, coll. Audéoud (MHNG). 1 ex. [VS] La Bâtiaz, 5.6.[19]49, leg. and coll. E. Handschin (NMBA). 1 ♂: Scuol GR 24.VIII.-10.9.[19]53, coll. V. Allenspach (NMBA). 1 ex. VD, Vincy, 6.6.[19]54 (MHNG). 1 ex. GE, Genève, Onex, 24.4.[19]59, coll. J. Rappo (MHNG). 1 ♂ GE, Genève, Onex, 25.4.[19]59, coll. J. Rappo (MHNG). 1 ex. GE, Genève, Onex, 10.5.[19]59, coll. J. Rappo (MHNG). 1 ♂, 2 ex.: GE, Genève, Onex, 15.3.[19]60, coll. J. Rappo (MHNG). 1 ex. GE, Genève, Onex, 31.3.[19]60, coll. J. Rappo (MHNG). 3 ex. GE, Genève, Onex, 15.3.[19]61, coll. J. Rappo (MHNG). 1 ex.: VD, Lavey-Morcles, Savatan, 28.5.1964, leg. and coll. P. Scherler (NMBE). 1 ex. Genf, 9. [19]66 (MHNG). 1 ex.: VD, Romainmôtier, 5.[19]70, coll. G. Toumayeff (MHNG). 3 ex.: Begnins [VD] c/nous, 9.5.1970, C. Poluzzi (MHNG). 1 ex.: Begnins [VD] 5.10.[19]71, Poluzzi (MHNG). 1 ex.: Begnins [VD] 17.10.[19]71, Poluzzi (MHNG). 1 ex.: Begnins [VD] 18.10.[19]71, Poluzzi (MHNG). 2 ex.: Begnins [VD] 21.10.[19]71, Poluzzi (MHNG). 1 ex.: Begnins [VD] en Moinsel, 27.10.[19]71, Poluzzi (MHNG). 1 ex.: Begnins [VD] 28.10.[19]71, Poluzzi (MHNG). 1 ♂, 1 ♀ VD, Begnins, Villa Caendet 1971, leg. C. Poluzzi (MHNG). 165 ex. same locality, breeding experiments 1971–1973 (MHNG). 3 ex. Suisse-Vaud, Begnins-élevage, VII-VIII. 1972, [C.] Poluzzi (MHNG). 23 ex. Vaud, Begnins, 25.IX.[19]72, C. Poluzzi (MHNG).

Remarks. Even though this species seems to have been once common and widely distributed in Switzerland, our survey of the available data paints a rather alarming picture. The most recent records of this species in Switzerland date back to the early 1970ies! Given the amount of collecting activity in many of its former localities in recent decades, its sudden decline cannot be entirely attributed to a lack of sampling.

The larvae of this species are notable for being pale brownish in colour (Fig. 9), in contrast to the dark brown or black larvae we observed for *Ch. kuesteri* and *Ch. latecincta*. This is based upon observations by Carlo Poluzzi in the canton Vaud in the early 1970ies, when he was still able to find this species in abundance at Begnins. At the time, he also reared this species on *Linaria vulgaris* and carefully documented his results in a drawing, which is kept at MHNG alongside his collection (Fig. 9). Bourdonné et al. (2013) provided a photograph of the pale reddish brown larva of this species.

In September 2022, an attempt was made to find specimens of *Ch. sanguinolenta* in vineyards around Begnins (Vaud), where it was last observed, but unfortunately without success.

Discussion

Our revision of specimens in various museums and private collections often revealed a colourful mixture of species standing under the same name in the collection. We found specimens of *Ch. kuesteri*, *Ch. rossia*, as well as occasionally *Ch. latecincta*, and even *Ch. limbata* (Fabricius, 1775), a member of the subgenus *Zeugotaenia* Motschulsky, 1860, all standing as *Ch. sanguinolenta* or *Ch. marginalis*! A thorough revision of the determinations often including extraction of the male genitalia proved to be paramount for gathering faunistic data. We therefore

Figure 9. Preimaginal stages of *Chrysolina sanguinolenta* on *Linaria vulgaris*. Drawing by Carlo Poluzzi, original in the MHNG.

advise biological recorders and conservationists working on similarly complicated taxa to refrain from uncritically downloading data from online databases, even if those originate from a museum collection, unless these data are clearly shown to be recently verified by a specialist.

A browse through the «citizen science» data of *Stichoptera* currently available on iNaturalist (https://www.inaturalist.org/, accessed 4th January 2023) also revealed numerous misidentifications, including some labelled as «research grade».

Due to the historical confusion of *Ch. sanguinolenta* with its relatives, we were not able to use a large part of the data in the published literature, unless backed up by voucher specimens. The only literature records we were able to accept directly are those contained within Kippenberg (2020) and Szallies and Brenneisen (2015).

From a conservation point of view, our current state of knowledge is too poor to evaluate the Swiss *Stichoptera* taxa using IUCN criteria. However, we can make some tentative statements about the conservation status of the taxa in Switzerland: *Ch. kuesteri* is much more abundant than previously known, particularly in Valais, with many recent records. It appears to be the least threatened of all the Swiss taxa. Our recent field observations of *Ch. kuesteri* in Valais (Mont d'Orge), may help to shed some light on the ecology of this species. Most of the beetles were observed within the vineyards, smaller numbers at southern exposed sites in the rocky step towards the peak of Mont d'Orge. Around Leuk, our targeted search also revealed a large abundance in a similar habitat. It is notable that Valais is a particularly well sampled area for Coleoptera, and yet most collections made during the past decades did not contain any *Ch. kuesteri*. Of the 86 voucher specimens we examined, only 21 were collected before 2000, over a range of 120 years, but 65 were collected since 2000. We therefore assume that this species has markedly increased in abundance during the last 20 or so years. Rheinheimer and Hassler (2018) made some similar observations in SW Germany (Kaiserstuhl area), where they found a sharp increase in sightings in recent years, also in vineyards. The reasons for this apparent population increase remain unknown. We can only speculate that the warming climate might have had an influence, or a change in the use of insecticides in vineyards.

Ch. latecincta latecincta is a high-altitude species potentially threatened by anthropogenic climate change in the long term. However, no drastic population decline was apparent based on our data. *Ch. latecincta norica* seems to have habits similar to the nominotypical subspecies, but with more widely scattered populations. Our failure to find recent specimens of this species in two well-known localities so far may point to a population decline. A potential threat is climate change and associated greening (Choler et al. 2021) of alpine habitats.

Ch. rossia is restricted to Ticino, but its populations appear to be stable and not in decline, with a fair number of recent observations.

Ch. sanguinolenta, despite being locally common at least in some regions until the 1970ies, has not been recorded from Switzerland for 50 years and must be feared extinct! It turned out to be a particular problem that many records of *Ch. kuesteri* and occasionally other species were misidentified as this species, obscuring its recent decline. Targeted surveys are now urgently needed, to find surviving populations. Furthermore, the causes of this species' decline need to be better understood.

Our rearing experiments for *Ch. kuesteri* and *Ch. latecincta* confirm a remarkable plasticity in the developmental time for both species. We also confirm a certain oligophagy, already postulated in the relevant literature, for *Ch. kuesteri*, which readily accepts two different species of *Linaria*, even though the host plant of this particular population in the field seems to be *Veronica*. For *Ch. latecincta* we confirm that other species than *Linaria alpina* are accepted (both genera are part of the Plantaginaceae, but in different tribes). Hence, we assume that both species may handle uncomfortable environmental conditions and/or loss of host plants to a certain degree. A regular development in winter can be confirmed for *Ch. kuesteri*. *Ch. latecincta latecincta* may also develop in winter, depending on the altitude and population. A larval development from spring to summer is likely to be the rule for the population on Griespass (2400 m), where a thick snow cover remains until early summer, greatly slowing down plant growth.

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Supplementary material 1

Label data, interpreted coordinates and collection references

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Data type: collection data of all Chrysolina (Stichoptera) species investigated.

Explanation note: Label data, interpreted coordinates and collection references of all investigated specimens of the following species are given: *Chrysolina kuesteri* (Helliesen, 1912), *Ch. latecincta latecincta* (Demaison, 1896), *Ch. latecincta norica* (Holdhaus, 1914), *Ch. rossia* (Illiger, 1802) und *Ch. sanguinolenta*. These data are the basis for the maps provided (Fig 3).

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